


234

REPORT
OF THE
JOINT COMMITTEE
OF THE
SENATE AND HOUSE OF REPRESENTATIVES OF PENNA.,
ON THE PUBLICATION OF THE
GEOLOGICAL SURVEY.



Digitized by the Internet Archive
in 2017 with funding from

This project is made possible by a grant from the Institute of Museum and Library Services as administered by the Pennsylvania Department of Education through the Office of Commonwealth Libraries

GEOLOGICAL REPORT.

Mr. Bigham, from

The joint committee of the Senate and House of Representatives, to whom was referred so much of the Governor's Message as relates to the publication of the *Geological Survey* of the State, made a report, which was read as follows, viz.:—

That they have given a careful consideration to the subject, and they present the following facts and views, showing the nature and importance of the work, and the grounds of their conviction, that it is the imperative duty of the Legislature to publish the fruits of this exploration as speedily as may be consistent with accuracy and completeness.

The Legislature of Pennsylvania, by act of the 29th of March, 1836, authorized, in the language of the said law, “a geological and mineralogical survey of the State, with a view to determine the order, succession, arrangement, and relative position, the dip or inclination, and also the comparative magnitude of the several strata, or geological formations within the State, and to discover and examine all beds, deposits of ores, coals, clays, marls, and such other mineral ingredients as may be deemed useful and valuable, together with all such details as may be necessary to make a full and complete geological and mineralogical survey of the State.”

The State geologist was directed “to make annual reports to the Legislature, of the progress of the work; and he was also to cause to be represented, on the State map, by colors and other appropriate means, the various areas occupied by the different geological formations in the State, and to mark thereon the localities of the respective beds or deposits of the various mineral substances discovered.”

On the completion of the survey, the geologist was to prepare for publication, a full account of the geology and mineralogy of the State.

By virtue of this act, Prof. Henry D. Rogers was appointed to conduct the survey, which he actively prosecuted with a corps of able assistants, for six years, until the appropriations were expended.

At the time of the organization of the survey, it was estimated that it would occupy at least ten years, but the financial embarrassments of the Commonwealth, made it expedient and indeed compulsory, to withhold further appropriations after the sixth year, and bring it abruptly to a close before it could be thoroughly completed in all its parts. Anxious to make the work as full and symmetrical as possible, the State geologist continued the exploration, and devoted himself to the preparation of the general final report for three years longer, laboring for the chief part of this period without salary, and at his own expense.

The whole mass of information and material collected by the survey, and thus finally systematized, arranged, and prepared for the press, was in compliance with the law, deposited in the office of the Secretary of the Commonwealth early in the year 1847, to await publication by the Legislature. In that position it has been allowed to remain to the present time, its large accumulation of carefully collected and patiently digested facts, bearing directly on many of the most important industrial interests of the State, not yet made practically available to any of the useful ends for which the survey was undertaken. The knowledge of our mineral possessions, thus successfully secured for the benefit of the citizens of Pennsylvania and the world, has, it appears, cost the Commonwealth an outlay of about \$76,657, but by a short sighted economy,

this fund of precious information, paid for by the people, is not yet the people's property. It is a valuable capital lying idle, a capital which your committee think is capable of yielding rich returns, but it is also susceptible, like much other wealth, of passing to waste by neglect. Already certain portions of the work, fresh and full of practical utility ten years ago, when the surveys were recent, are behind the wants of the day, and need minute revision.

A brief statement of the extent and character of this guide to our mineral resources will of itself suffice to prove, that its publication cannot fail to benefit every economic interest of our State and country.

In the revised and expanded shape which the Committee recommend as necessary to the fullest usefulness of the work, it will consist of a descriptive text of about one thousand quarto pages. This text is to be illustrated by *five* geological maps, representing in minute detail the geographical distribution and range of all the various rocks, strata, and mineral deposits within the limits of the State, even to depicting individually the out-crops of the numerous beds of coal.

At the same time, the text and maps, both reciprocally illustrative, are to be again still further elucidated by an extensive series of general and local sections, shewing the underground positions, inclinations, and undulations of the strata, so that the more expanded of these will exhibit the actual subterranean course of every layer of coal or other desirable deposit, and will furnish data exact enough for estimates of the depths and dimensions of the local coal fields, the smaller basins, and even the separate coal beds.

In addition to these auxiliaries, the text will receive still further explanation from numerous figures of characteristic fossils. These are among the geologist's surest guides to the discovery or recognition of the several various strata or formations, and their subdivisions. And to render the work still more intelligible, practical, and withal attractive, various topographical features and points of scenery, such as sometimes present in the external landscape an almost unerring key to the internal geology, are to be made familiar to the eye, in a series of beautifully-executed pictorial sketches from nature, to be rendered upon steel.

The text is to be yet further elucidated and embellished by a multitude of wood-cuts, to the number of several hundred, representing every diversity of geological feature and condition of instructive value, including especially a great variety of locally-interesting cases of stratification, which severally afford a clue to the mineral wealth in their respective neighbourhoods.

Such is necessarily a concise and imperfect description of the form and scope which your Committee propose the Geological Report of the State shall assume on its publication. In its present shape, it embodies faithfully and fully the results of the survey as carried on, up to and even beyond the cessation of appropriations for it. The book and its illustrations actually consist of about three-fourths of the total quantity of material which it is now in contemplation finally to produce.

As we now possess it, the extent of the text is equivalent to about eight hundred quarto pages. The maps are two in number, but these are both of them elaborate. The quantity of geological sections and other delineations of stratification is estimated at three-fourths of the final amount, while the pictorial illustrations and the fossils are less in the same proportion.

Your Committee, after a minute inspection of the materials of the Report in the form they now possess, and a careful consideration of the question of their value as a true guide to the vast mineral riches, the interesting geology and beautiful topography of the State, wish unanimously to avow their conviction, that the publication at the date of the completion of the survey, when an appropriation for that purpose was earnestly suggested by the State geologist, would have been an act of the soundest public policy, promoting in many ways the industrial prosperity of all parts of the Commonwealth.

Several years have elapsed since the work was in this state of maturity for the press, and a still longer period has now gone by since some of the most important and fruitful portions of the survey were made, those, for example, of our extensive, valuable,

and intricate anthracite coal beds; and in the interim there has been, in this and the other mining districts of the State, a prodigious advance in all our colliery operations and in the development of our mineral deposits, contributing to, and at the same time calling for, an increase of exactness in geological description.

In consideration of these and other circumstances, connecting the geological survey even more intimately than at any former stage in our progress, with our mining, our manufacturing, our agricultural, and our commercial prosperity, your Committee recommend that a careful revision shall be made of all those parts of the survey which the lapse of time has been making obsolete, and that in its altered and expanded shape the final Report shall be published in a style of accuracy and taste essential to its scientific character and its practical objects, and creditable to the reputation and resources of Pennsylvania.

It has been ascertained, from estimates submitted to a committee of the Legislature in 1848, that an edition of one thousand copies, quarto size, with the maps and other illustrations, in the form of a separate atlas, could have been procured in the best style of the art for about \$19,000, and an eminent publishing firm has at a request from your present Committee, presented proposals for executing it in a satisfactory manner, under the indispensable supervision of the State Geologist, its author, and in conformity to conditions suggested by the Committee. These proposals stipulate to produce an edition of one thousand copies for the sum of \$15,833, in further consideration of the transfer by the State of the copy-right to the publishers.

An examination of these proposals, and the estimates which accompany them, shows that the contemplated enlargement of the book and its illustrations, growing out of the proposed additional surveys and revision, will cost about \$3,886, out of the \$15,833 of total cost. By this very moderate increase in the expense of publication, your Committee firmly believe the true value of the work, as a practical guide to the development of our mineral wealth and in its usefulness to the whole community, will be more than doubled.

To publish the Report in the shape it has at present, without the amendments and revision required by the extensive progress made within the past ten years in developments connected with the coal fields, the iron manufactures, and also the agriculture of the State, would be to give the public a body of statements, in some parts already half superseded by more exact and more recent knowledge. Every duty of patriotism to the Commonwealth, and every view of policy to her interests, should prompt the Legislature to publish to the world the fullest and clearest representation procurable, of the resources which she possesses; but to put forth descriptions, some of which are behind the developments of the day, would be, not to proclaim her true resources, but to disparage them.

In order to embody in the geological report that more exact and detailed species of information which the disclosures of recent years will enable the geologist to procure a systematic re-survey of a large portion of the anthracite districts will be indispensable, and a revision of the more progressive districts of the bituminous coal fields west of the mountains, seems scarcely less important. Among the fruits of such a re-examination will be an increased degree of accuracy in the general geological map, a new geological and topographical map of all the anthracite basins, to supersede the present very creditable one which now accompanies the report, and a minute guide map to the individual coal beds of a large part of the Pottsville basin. There will likewise be produced, an extensive series of working sections, such as are felt to be greatly needed by the mining engineer and collier, in their riskful and expensive operations. The distribution and situation of the nearly horizontal layers of coal, iron ore, limestone, and other materials in the western counties, will be yet more fully illustrated than they now are, by an additional set of vertical sections or columns, showing the strata in their several depths below the surface of the county in each neighborhood, and their relative thicknesses and distances apart.

But to represent the geology with this degree of fidelity and close analysis, the re-survey should be conducted with the aid of instruments for measuring and levelling. This more critical research, should be facilitated by the labors of a small band of

miners, for exposing the out crops of the coals and other strata. The State geologist will therefore require the services of a corps of geological surveyors. Thus provided, he could complete, it is believed, the revision so much to be desired in two seasons of field examination. It is estimated also, that about two additional years will be then required, to enable him to embody the results of these and his other researches into the report, and to supervise the publication of the whole. The already matured portions of the work, such as the topography of the general map, and a large proportion of the more elaborate sections, the engraving of which will involve much time, can be advantageously commenced upon almost immediately. Your committee has ascertained, that upon this plan, the survey can be perfected as far as its practical and scientific objects demand, and the text and illustrations of the report amended and increased, and published with the requisite accuracy in a period of about four years from the present date.

The cost to be incurred by the proposed revision, including a salary to the chief geologist for the four years of his supervision of the press and his other services, and the pay to his assistant corps of surveyors, and a small band of miners, for two seasons, will amount, upon a rigidly economical estimate, to \$16,167. Your committee are gratified to have ascertained, that for so comparatively small a sum, the value of the Final Geological Report, the surveys for which have cost \$76,600, will be unquestionably doubled. For an expenditure but just equal to that of a single year of the original survey, when in full activity, the deficiencies of the work, caused by its premature stoppage, and the subsequent progress of developments, can be supplied, and the whole survey made adequate to meet the wants and the most exacting wishes of the citizens and friends of Pennsylvania.

Your committee, therefore, recommend for the revision and publication of the Final Geological Report, a total appropriation of \$32,000, the sum of \$15,833 to be applied to the publication of the report in its revised and expanded form, and the sum of \$16,167 to be employed in procuring the requisite new surveys and additional researches, and the supervision of the press in the various details of printing and engraving the report.

If this thorough revision is authorized, the committee believe that the delay in publication will be fully repaid. A large portion of this time has been devoted by Prof. Rogers in the employ of private companies, to detailed and thorough explorations of portions of the mining districts. The knowledge thus acquired, and the opportunities he has since enjoyed, of comparing his own views on this eminently progressive science, with the opinions of scientific men throughout America and Europe, must largely add to the value of this publication. And, perhaps, it is not out of place for us to add, that in addition to all other motives to prompt him to fidelity in the execution of this trust, he is fully aware that upon the merits of this work, his reputation among men of science must stand or fall.

A brief comparison of the total cost of other geological surveys with that of Pennsylvania, supposing the revision now recommended to be sanctioned by the Legislature, will be instructive in this place, as shewing, that notwithstanding the disproportionally greater amount of intricate geology and of mineral deposits to be described and represented by our survey, it will have been executed at a cost eminently economical, when judged by the outlays upon other explorations with which it should be contrasted.

The only other geological survey which seems to have aimed at being similarly elaborate with our own, is that of the State of New York. Let us compare the two explorations: first, in the respective amounts of time devoted to them, and in the next place, in the expenditures connected with them. The strictly geological department of the scientific survey of New York, consisted of field explorations, continued during four years, by five principal geologists, and five assistants, working in different fields, and of closet and field researches, relating exclusively to the fossils, by one of the geologists during six subsequent years. Thus, the total amount of time there expended, has not exceeded the equivalent of twenty-six years. But the time applied by the State geologist of Pennsylvania, and his, at one period, large corps of assist-

ants, to the study of our geology, is equivalent to one man's incessant researches for fifty-six years, and it will amount to sixty-six years, if the revision proposed be undertaken. New York has published seven volumes, in quarto form, of geological reports, and a small geological map, with numerous other illustrations; while Pennsylvania is asked to print what is equivalent to about two volumes, but with the text very fully illustrated. The expenditure upon the geological part of the New York survey and reports has, we learn, largely exceeded \$200,000; while the total cost of our own exploration, when revised and printed, will not quite reach \$108,000. In other words, we have procured by our organization of the survey, much more than twice the actual amount of exploration for not more than one-half the expenditure in money. This shews that Pennsylvania has been extremely frugal in her scale of outlay, for a species of knowledge which, considering the character of her native wealth, and her destiny as a great mining and manufacturing community, it vitally concerns her to possess and use.

The great geological survey of France, engrossed the time of two geologists-in-chief, and a numerous corps of geological engineers of the French school of mines, for the term of twelve years, in the production of a geological map, and of two volumes of descriptive text.

We may add, that Great Britain, sensible of the vital importance to all her industrial interests, of a thorough examination of her strata, has been conducting a close and very elaborate geological survey for about twenty years, and that for the past twelve or thirteen years, it has been on an organization both extensive and costly, commensurate with the greatness of her mineral wealth, and worthy of her high ambition and eminent practical wisdom.

Your committee having, in the discharge of their duty of inquiry into the question of publication of the geological survey of the State, become more forcibly impressed than ever with the high practical utility of such an exploration, cannot omit embracing this occasion for presenting some of the prominent considerations which have influenced their judgment.

A fact which must weigh strongly with all reflecting minds wishing to acquire a just estimation of the real bearing of geological researches upon the interests of society, but not sufficiently initiated in the science itself, or in the principles of the related arts, to appreciate the connection, is the high and general importance now awarded to it by all enlightened governments, both in our own and other countries.

Thus, it appears that nineteen States of our Union, have engaged, more or less perseveringly, in geological surveys, and where, as in the instance of Pennsylvania, financial embarrassments compelled a suspension of the work, several of these have either resumed or are preparing to resume and finish, their examinations. Massachusetts and South Carolina may be cited as having resumed, revised, and elaborately completed their surveys, while we believe those of Maine, Virginia, Ohio, and Illinois, are likely to be soon renewed. This recognition of the utility of this species of investigation, is further shown in the pains taken in several countries to publish periodicals devoted especially to geology and the arts pertaining to it. Such a publication is the "*Annales des Mines*," issued under the auspices of the French Government, and such is the work produced at intervals by the British Government, entitled "*Memoir of the Geological Survey of Great Britain and Ireland*." A further proof of this high estimation of the science, is the fact that the French Government supports, at a large expense, her School of Mines, for the especial object of educating and training skillful mining engineers and practical geologists, to aid, whenever called upon, the development of her resources; and so fully awake is the English Government to the dependence of much of her industrial prosperity upon her efforts for encouraging practical and scientific geology, that it is fostering with much care a nobly endowed institution, in London, called the Museum of Economic Geology, where everything that can illustrate the stratification and mineral wealth of the country, everything that can assist her people to a clear knowledge of the composition of their mineral raw materials, to the best methods of finding, tracing, and raising them from the earth, and afterwards converting them to the useful purposes of life, are collected and displayed

gratuitously for the inspection of the public, or the special study of the numerous classes needing the information. A library of books on geology and the kindred sciences, on mining and the arts connected with it; a bureau of geological and mining charts, embracing plans and a registry of all underground working and surveys; also, models of the best machinery connected with mining, of the best arrangement for ventilation, and of the various methods in use in different countries for propping, timbering, and draining, are here assembled and accessible for study. To these means of information are added a valuable geological museum, of all the rocks and their contents, and the soils derived from them, every kind of coal for fuel, metallic ore for smelting, clay for the manufacture of pottery or porcelain, and sands for glass making, and every species of building stone and ornamental rock, in rough and dressed or polished state, is here arranged for inspection; and to add yet further to the instruction they convey, every species of mineral raw material which is transformed in the operations of the arts, is exposed in all its successive stages of manufacture to its highest state of finish.

Two chemical analytical laboratories for the examination of fuels, assay of ores and other indispensable researches, and a noble lecture room as a means of diffusing yet wider to the industrial public, the fruitful facts and principles of geological science and its arts, complete the admirable working machinery of this wisely-planned institution. Its respective departments are administered by geologists and chemists, who are among the very ablest in Great Britain, and it is presided over by one of the foremost of European geologists, Sir Henry De la Beche, who is at the same time at the head of the geological survey of the country, with which this museum of economic geology is intimately connected.

After this concise, but sufficiently convincing statement of the high sanction which geological explorations receive from countries and communities, which are admittedly foremost in the cultivation of every science and art that are of practical utility, it would seem a superfluous labor if we entered at any length into a general argument in defence of the usefulness of geological investigations. A few prominent and obvious reflections may, however, be acceptable to those who have not given the subject much study, and who desire to possess the means of arriving at an enlightened judgment. Justice to the cultivators of geology, and to all who advocate the grandeur of its doctrines, and the beneficent usefulness of its truths, calls upon us to testify our conviction that it is eminently, we might almost say pre-eminently, a science of observation and of facts. Like any other branch of human enquiry, it has misty points on its horizon, where the imagination kindly given to man for elevating uses, may please itself in speculation, but the same is true of the most positive of the other sciences of astronomy, chemistry, the philosophy of mechanics, and equally of mathematics itself. On the other hand, it covers a vast field of definite and severe research where all is tangible and known, where the same phenomena have been patiently and closely scrutinized and compared, by a host of diligent enthusiastic discoverers in various quarters of the world, and for the past one hundred years. While the larger general deductions and great principles of this science, lead the mind soaringly up to a vision of some of the broadest and most captivating pictures of the sublime plan and harmony of creation ever yet disclosed to human thought, the clearness of its multitude of facts, the logical accuracy of its calculations, the certainty of its practical rules, and the mighty power of discovery which these confer, make it in its various bearings on the wants and comforts of mankind, as beneficent in its application as it is noble in its higher teachings.

The momentous importance of a geological investigation of a country to its industry and growth in wealth, is immediately appreciated when we consider rightly the bearing which it has upon all the leading avocations of the people. To the mining interest it is indispensable, as the only attainable and safe guide to the mineral masses below the surface, and the only clue in tracing them amid their frequent displacements and shiftings. It alone can indicate, with any approach to precision, where the materials are, to what depth they descend, and how they can be most securely and economically reached, pursued, and lifted to the surface. It alone can teach by close observation

of a sufficient multitude of related facts by multiplied measurements and unerring geometrical deductions, and by its systematic methods of development, whether a supposed deposit is in the place imagined, or of the thickness assumed, or in a position to repay the expenditures necessary to expose it. In all cases of uncertainty (and from the manner in which the earth's vast riches are hidden, the adventures of mining are proverbially riskful), geological research alone supplies the elements for calculating the probabilities of success or failure. In proportion to the precariousness of the art, and to the magnitude of the masses of capital and industry embarked in its operations and hanging on its results, must be the value of the information which reduces its risks, and supplies it with the only data it can get for calculation.

To the manufacturing interests of a country, a systematic scientific investigation into its mineral resources is scarcely less essential than it is to the mining. It contributes to discover, and make abundant and cheap, those numerous mineral substances which are the raw materials of many of the leading branches of the arts in every manufacturing community, and upon the degree of facility in securing which oftentimes depends its whole industrial prosperity. In the intense struggle of competition which the dominant nations of the earth are now waging against each other, a peaceful but energetic strife, even more decisive of their fate than hostile war itself, the whole issue rests at last, in many instances, on merely such differences of cost and supply of the mineral raw materials as are entirely within the control of geological developments. It will not be enough for a people to possess these natural treasures, they must be able to raise them from the earth at the prices sternly stipulated by external competition. They are gifts of priceless riches, to such as ask from nature the easy key of knowledge which alone unlocks them, but to industry without knowledge they are no gifts at all. A single glance at the relations of the industry of a community to the price it pays for certain native products of its strata, will suffice to prove this. In the manufacture of iron, for example, where the other elements of expense are at all alike, as is the case between several iron-producing districts in the United States, the whole success or failure of some of the largest enterprises has depended on the degree of knowledge or ignorance which presided in the selection of the places for investment. Of this, our own State of Pennsylvania and the neighbouring State of Maryland furnish numerous instructive instances.

To those familiar with the economic details of this large element of a nation's progress in the leading arts, is known how mainly the prosperity of many a smelting works depends on some nice point in the geology, some question of the securing a fit supply of a certain ore or flux, or some problem of the opening or draining of a mine, which only geological research can solve.

Equally conclusive illustrations might be produced from the manufactures of porcelain or of glass, to prove how dependant their success must ever be on the condition of geological research and knowledge within the spheres which supply them with their raw materials. We will permit ourselves to adduce one instance respecting the glass manufacture, which has come to our knowledge. Some of the leading glass works of New England and New York are now furnished with an admirably pure white sand, from the use of which they are deriving great advantages in the quality of their ware. This material is the substance of a pure sand stone rock in western Massachusetts, to which their attention was called by a geologist, who was consulted to procure a suitable pure sand, and who has traced the rock for many miles. More than one of these glass works was previously under the necessity of importing sand to New England from the gulf of Mexico and from Missouri, at oppressive prices.

It is obvious that both the mining and manufacturing interests of our people have now reached a stage in their career of competition with the like interests of other countries, at which all the available resources of geological science and art have become imperatively needed, to enable them to maintain the race. While the governments of France, and England, and Belgium are doing all in their power to stimulate their manufactures of iron, and porcelain, and pottery, and glass, and every other art which uses a mineral as the raw material, or fossil coal as the fuel, or as the power to propel the machinery, while to cheap labour these countries are adding the resources

of geological skill to still further cheapen the materials upon which the labour is employed, surely it is doubly incumbent upon us to counteract the competition, by a yet greater attention to those elements of economy which we *can* control—the elements of skill and knowledge.

At an earlier point in our progress a less share of science was demanded of us, but now the growth of population and the expansion of the business of the country, making the stakes invested in mining or manufacturing greatly larger, precisely as the energy of external competition is making them less secure, the very existence of these struggling arts demands that we shall succor them all we can, by the discoveries and suggestions of every branch of knowledge, but especially of that branch from which they derive their life.

The element of all others, upon which a people's progress in the useful arts is most dependent, is the element of fuel. Without this potent agent of *heat*, man is powerless to work any of those manifold changes upon crude matter which constitute the arts, and which are at once the glory and the prize of his civilization. But with the command which fuel gives him of this subtle and mysterious influence, he subdues such resistances, concentrates such great forces to his aid, and performs such plastic changes in the forms and properties of things, that when he pauses to behold his achievements, he is lost in very wonder at the power which he has wielded.

Already, at the present day, and probably for all time henceforth, the whole industrial destiny of every people will be shaped by the degrees to which they can severally possess themselves, of this obedient slave of human will, and those lands which own it in the form of *coal*, the most concentrated form of fuel, and the only form in which it is extensively available in the arts, are the countries to which the sceptre of all industrial strength, and ultimately of material power, inevitably must pass.

Applied in awakening the energies of steam, coal in its different shapes controls a force which is everywhere fast superseding the water power of the continents and the winds of the ocean. While over these it has this superiority as a source for mechanical results, that with a latent strength which far transcends that of either of those propelling agents, its performances are graduated to every wish, and are subservient to every touch.

By the use of this fuel, man applies a blast to the piston of his steam engine which is stronger than a raging hurricane, for it will drive the largest vessel in the very teeth of the tempest. Few even of the persons who direct this colossal power, have yet formed to themselves any true conception of the enormous amount of force which a given moderate weight of coal represents. It is susceptible of easy calculation, that four ounces of coal, notwithstanding all the existing wastefulness of heat in the locomotive engine, are sufficient to drive, on a level railroad, a load of one ton weight, through a distance of one mile, at a speed of twenty miles per hour; and it has been computed, that in only three tons of coal there resides quite as much actual power as a strong man puts forth during his whole lifetime.

The estimate is perhaps not extravagant, however paradoxical at first blush it may appear, when we consider in detail the purposes to which the steam engine is now employed in modern science and civilization, to say, that steam in all its applications now performs an amount of labour equal to that of the nine hundred millions of the human race who at present occupy our globe. If this is true while the contemporaries of Fulton and Watt are yet in active life, who can estimate the condition of things one hundred years hence.

With these facts of the potent efficacy of coal before us, who can doubt that upon the relative abundance and cheapness of it, must depend the relative progress of different communities in manufactures, commerce, and agriculture, and, in fine, in every art requiring either much or little strength, which aims at moulding matter, or transporting commodities or men; or who can fail to believe, that the busy mechanical population of the age we are entering on, and all the industrial arts are drawing themselves nearer and nearer to the accessible coal fields of the earth. As warmth is the apparent first essential to life, so the heat which lies dormant in our fuel is to prove hereafter, it would seem the source of the highest life to nations, and the main support in the

end, of the worlds teeming children. For the last one hundred years indeed, manufacturing capital and industry have been drawing themselves closer and closer to the developed coal fields of the world.

In this higher philosophy than man has ever devised in the developments of Almighty wisdom, as manifested in the geological formation of our vallies, our hills, and our mountains, would your committee inquire, what should be the destiny of our people? When thus investigated, we learn that it is not simply a matter of accident, that our cities and counties of manufacturing industry are still the workshops of the union. Here, too, we are taught, that Pennsylvania has no more accidental temporary interest in sustaining, on the part of our national government, that policy which will give uniform adequate encouragement to her domestic industry. Her interest must continue until her coal beds and ore banks are exhausted. Thousands, probably millions of years, may not accomplish this. Here, too, we have the legitimate sphere of human legislation.

It should never attempt to build upon soils, or situations unfitted therefor by nature, a business which even time cannot render productive. It should only attempt to render useful and available for the purposes of civilized man, those crude materials now unproductive, which Providence has lavished upon us—no legislation should ever attempt to change Louisiana into a manufacturing, and Pennsylvania into cotton and sugar-growing States.

Are we not then justified in saying, that a scientific survey which guides us to this fuel, and cheapens it to all the regions near which it is produced, must there attract, by an irresistible force, those two elements of all prosperity.

To that great leading interest *agriculture*, a geological survey is both directly and indirectly beneficial, to an extent which well deserves the careful consideration, not only of every farmer, but of the Legislature. It conduces directly to this interest by pointing out the sources from whence the various soils of the region are derived, and the belts of country where the same soils prevail, so that the agricultural experience of separate localities upon identical soils may be compared together. It analyses the strata, and shows which layers are fertilizing and which not, and traces on the geological map such as are natural manures, discriminates between the pure limestones and the magnesian ones, between those which possess the all-powerful element of phosphorus and such as do not, and indicates what shales and other constantly decomposing strata are already naturally calcareous or gypseous, and are competent of themselves, by proper mechanical treatment, to replenish the soil sufficiently with lime and plaster, and what others are destitute of these essential elements, and yield soils which require their artificial introduction. It calls attention furthermore to, and furnishes in fact much knowledge indispensable to any right system of drainage.

An improved and truly economical culture of the soil must be founded upon an exact knowledge of the materials of which the soil is composed, and this indispensable knowledge can only be procured through a careful study of the rocks or strata out of which the soils are derived. Hence it is, that Geology is now universally regarded by the professional teachers, scientific writers, and the most skilful men of practice in agriculture, as equally fundamental with chemistry, in its relations to sound methods of cultivation. Of this no better proof need be asked than the titles and scope of all the treatises, both comprehensive and abridged, of one who is perhaps the ablest expounder of the principles of this great art now living, Prof. James F. W. Johnston, of England, who has devoted the labors of a lifetime to the production of works expressly on "*Agricultural chemistry and Geology.*" In a recent "*Report on the agricultural capability of the Province of New Brunswick,*" illustrates in various ways, how "the possession of a good geological map is of much importance to a State, as an aid in determining the cultural value of its surface, of what it is capable, and how its capabilities are to be developed."

A little consideration of a few fundamental facts in agriculture and geology, will render obvious the advantages which the intelligent farmer may derive from a knowledge of the strata of the district where he dwells.

The first practical problem which the agriculturist in any region must study, is the

adaptation of the crop to the soil, the climate, and the market. But to know its adaptability to the soil, he should have a clear conception of the nature and composition of the strata around them; for without this knowledge he can get no true insight into the chemical and mechanical properties of the soil, which is nothing else than the substance, in whole or part, of those rocks in a decomposed or decayed condition.

The whole art of preserving or improving the fertility of a soil, consists in replenishing it with those elements which the crops are ascertained to abstract, and in the proportions suitable to repair the waste, and to meet the indispensable demands of vegetation. But how can these proportions be known, unless we previously ascertain what the decomposing rocks themselves supply, and what they fail to furnish. When it is understood that a soil to be truly fertile, must consist of at least the following substances, some of them in large and some in minute quantities, and that they are all equally necessary to its productiveness, the importance of a correct geological knowledge, indicating their presence or absence in a particular locality, will be plainly perceived—*silica, alumina, lime, magnesia, oxide of iron, potash, common salt, and phosphoric acid*—and this will be still more distinctly seen when the inorganic elements in any of the ordinary crops are shown in comparison. In the case of red clover hay, as an example, there are *silica, lime, magnesia, oxide of iron, sulphuric acid, phosphoric acid, potash, soda, and chlorine*, in all one hundred and twenty-nine and a-half pounds in a ton of hay. As the abstraction from the soil of either of these ingredients will greatly impair its suitableness for this particular crop, it is manifest that it behooves the farmer, as a first step to the skilful culture of his land, to learn from the composition and geological origin of the rocks which have produced and are still producing his soil, whether these various constituents, indispensable to his purpose, are naturally there and likely to be renewed, and which of them he must himself supply.

The animal which cannot thrive without a due proportion of lime and phosphorus in its bones, can by ranging widely for its food be almost sure of those ingredients; but the plant is rooted to one spot, and if these and the other earthly elements, not less indispensable to its nutrition, are not immediately within its reach in the soil, the farmer must introduce them. But how can he possibly know what it is that is deficient, until the chemical geologist makes it clear to him, from a previous study of the composition of the rocks and of the soils into which these rocks decay.

It may be stated as an undeniable truth, that without an acquaintance with the local geology of his vicinity, the agriculturist can never avail himself of the whole of his natural resources, or make due and grateful acknowledgements in his industrial practice of the bountiful sources of wealth which the beneficent Creator, with lavish kindness, has spread beneath his feet. To till the earth and call forth her fruits, is the happy destiny assigned to the great mass of mankind, but through it there would seem to be in reserve a destiny still nobler, the cultivation of his own faculties and powers, resulting from his eagerness to convert to human uses, by increase of knowledge, the qualities of common things. In studying the very commonest of these, if they be but the crumbling clods of stone that strew his fields, he sees everywhere that the physical laws are divine appointments.

Of the indirect benefits to the agricultural class from such an exploration, little need be said, they are such as will be shared in to a greater or less extent by every citizen, and must be acknowledged as soon as hinted at. One of the most obvious of these is the operation of such a survey to render coal abundant and cheap, for the various important uses for which the farmer must have fuel, such as the burning of lime, the making of bricks, or the furnishing his neighbourhood with steam, saw, and grist mills, in the absence of water power. To these advantages let us add the preservation of his wood for fencing, building, and other uses than burning, and the liberty it gives him to appropriate a larger share of his land to growing *crops*, while a less share is given to growing *timber*.

But probably the most important indirect boon conferred on the agriculture of a country by geological developments, is the influence these have, by stimulating its mining activity to attract population *inland*, and to create thereby *home markets* for

the produce of the soil. Not to wander to England and Belgium for proofs, in the extraordinary pictures there presented of this quickening influence on agriculture, it is only necessary for us to look at home, to the prosperity which already smiles in the Red Shale and other vallies which begirt our anthracite coal fields, to witness the happy results of the ties which bind the welfare of the great class who till the surface, to that of the population who delve for other riches beneath it.

It is too obvious for argument that a map and description which display in their true position all the varieties of strata, and consequently their soils within our borders, must be a most valuable aid in exhibiting our agricultural means of wealth, and for inviting hither the best class of settlers. We have lost much desirable population by the undue prominence given to western lands, which do not compare so favorably with our own as to compensate for the peculiar disadvantages to which they expose emigrants from New England and from Europe. We might refer to many examples of a sudden impulse given to agriculture, by the publication of the results of geological surveys. Several striking instances are presented to our thoughts. One relates to the marl region of New Jersey, where the farms have been enriched, and their produce multiplied by the disclosures of the true character and extent of beds of green sand or marl, by Prof. H. D. Rogers; and the other has reference to the old farms of Eastern Virginia, which have been revived since Professor William B. Rogers made known the abundant deposits of calcareous marl of that portion of the State. Indeed the emigration to that worn-out region, from the northern and eastern states, has been excited mainly by the prospect of benefits dependent upon the marl manures. We may also mention, that methods employed in the Netherlands, converted the most barren sands into fruitful fields. And even the white drifted sands of Cape Cod are now changing to bright green fields, and much of the credit is due to a geological report made by Professor Hitchcock, of Mass., who was ambitious to point out means to make two blades of grass, or two ears of corn grow, where but one grew before.

The foregoing views, applicable to any country owning mines, manufactures, and an improvable soil, have an especial force in the case of Pennsylvania, for her territory is pre-eminently rich in all the best treasures which the strata of the globe can yield. Coal in all its varieties, iron ores of every sort, and pure limestones, slates, clays, and building rocks, are spread in a lavish abundance, scarcely paralleled by any other equal district of the world's surface. In coal, the most precious of all mineral wealth, she has an estate larger far than that of any other commonwealth in America or kingdom of Europe. The estimates of the geological survey, prove the State to contain at the least 11,000 square miles of productive coal strata, with such an available average thickness of the coal, as is equivalent to more than seven tons of the fuel under each square yard of this prodigious area. More than 20,000,000 of tons of this concentrated form of power, is then the average quantity allotted to each single square mile of these 11,000. Or measuring it by its equivalent in human physical force, the total strength which slumbers beneath our soil, is the inconceivable aggregate of 11,000 times the energy of 7,000,000 of men extended for a life time.

Commensurate with our anthracite and bituminous coal are the beds of iron ore, like the fuel which lies adjacent, or within easy access to them, inexhaustible for thousands of years. The mining and transforming of these through all the various processes of manufacture, and their transmission by the channels of a constantly expanding commerce to market, must create within our borders untold millions of wealth.

Your committee cannot here abstain from adverting to a few interesting statistical points, showing the already large production of the State in coal and iron, and the rate at which this production has been increasing.

The present annual yield of the coal mines of Pennsylvania is estimated as follows:

Anthracite to be sent to the market in 1851,	3,700,000 tons	-	-	\$14,800,000
Bituminous coal, domestic and extra State consumption	-	-	-	3,000,000
				<hr/>
Having a value at the points of consumption	-	-	-	\$17,800,000

But large as this return has already become, it sinks into insignificance when we

calculate from the past rate of growth of the anthracite coal trade, the magnitude it must attain to at the lapse of only twenty years. Assuming, as we think we are justified in doing, that its product has been doubled each successive seven years, and that this rate of expansion cannot be materially checked in the present generation, then by the year 1870 it will have grown to the extent of 25,000,000 of tons. And the whole yield of the State will probably have approached the present enormous product of Great Britain, which cannot be much less than 40,000,000 of tons. England doubles her vast yield in about twenty-five years.

The annual product of our furnaces, forges, and rolling mills, was, in 1846, estimated by a State convention at over \$23,000,000. The natural increase, even in the present depressed condition of the iron trade, cannot fall below \$28,000,000. The amount expended by private canal and railroad companies (exclusive of the State works), in order to reach the mining districts of Pennsylvania, has been \$40,000,000. When we take into consideration that the manufacture of railroad iron in the United States is yet in its infancy—that the use of our anthracite and bituminous coal in the process of producing iron is just in process of practical development—both of which branches must incalculably add to the value of our staple products. We scarcely know what would be a fair estimate twenty years hence, of the annual value of the mines of Pennsylvania.

If the iron manufactures of England doubled its product, as is well known it did in twelve years, from 1836 to 1848, and amounted at the latter date to 2,000,000 of tons, and our own attained, as it did in 1847, the magnitude of 3,500,000 tons, it is very easy to see that at the rate at which production marches in our country, this branch of our industry must in twenty years reach dimensions truly colossal.

The gold mines of California, about which the public mind is so much excited, sink into insignificance in the comparison. At best, a generation or so will exhaust the gold of the former, while the mineral wealth of the latter must be constantly and steadily increasing. Spain, for three hundred years, monopolized the gold and silver mines of America, and is now the most impoverished country in Europe. Great Britain, during the same period, by the assiduous use of her coal, her iron, and her domestic industry, is now the grand regulator of the money market of the civilized world.

The same general principles in regard to the ability of a coal and iron district to sustain a dense population, holds good in regard to national wealth. A district of country of that character will afford sustenance and employment to a more numerous population than the richest agricultural region, or the most productive gold mines. All experience proves that mining and manufacturing districts always become the centres of a densely-crowded population.

The region included within the anthracite coal fields has increased tenfold in population within twenty-five years. Ten years ago, the State of New York, fostered by her public improvements, and having monopolized the foreign trade of the Union, seemed to be firmly established as the Empire State. The census of 1850 will exhibit the State of Pennsylvania as largely gaining in the race of improvement. The elements of Pennsylvania progress are her inexhaustible mineral resources—especially her cheap fuel, which is making her the workshop of the Union, and building up the largest coasting trade along the Atlantic coast.

But it is to be remembered, that rich as our State is in the materials of wealth, she has to encounter a formidable and growing competition with other countries; and that when we ask private capitalists and men of enterprize to employ their means within our borders, we must be prepared to show at least equality of advantages with other States. There is a necessity of availing ourselves of all that science can do in calling out our resources and directing our industry. Now, there is no mode as concise and effectual for the exhibition of our eminent advantages to the attention of the world, as a description of our soils and mineral veins and beds in the form of a Geological Report.

Let us notice, for example, in a single aspect of the case, what this must gain to us. British journalists are at this moment sneering at the competition of Pennsyl-

vania iron works, and ridiculing their location. What better answer for *the future* can we make, than a systematic exposition of our numerous excellent localities for the cheap manufacture of iron.

In surveying the extraordinary picture which we have presented of the past progress of Pennsylvania in mining, and the one great art of iron making, which may be taken as indexing her entire industrial movement, your committee have become strongly impressed with the belief, that her rate of advance in the future will be, in no small degree, contingent on her encouraging, by every effort of wise legislation, first, the development of her native riches, and secondly, the advertisement of them widely to the world. Another reflection which is strongly suggested by the same review, is the the greatly larger amount of capital and industry which are now to be injuriously affected by a neglect of geological researches, than at the time the geological survey was originally organized. If it was an act of enlightened policy and sound forecast, in 1836, to institute such an exploration (and it was so considered), much more expedient must it now be to possess ourselves of its fruits, ripened by revision, to meet the demands of the present hour.

In 1836 the product of our State in anthracite was scarcely 700,000 tons; while now, at the lapse of fifteen years, it will this year be five times as large. In the same interval, the iron furnaces have increased the make of pig metal to about four-fold what it was.

Your committee, in conclusion, wish to express their deep conviction that Pennsylvania, by thus adding to the knowledge of her vast internal resources, would substantially benefit all her diversified interests, and injure none. There is no doubt, that in many minds a prejudice exists against all those pursuits tending, as they believe, to produce irregularities in wealth and social condition; and hence, such persons regard the comparative equality of agricultural life, as alone compatible with democratic institutions. Mature examination, however, should satisfy them, that, this sentiment is not only a base libel upon republican government, but also a reflection upon the wisdom of the divine administration, as thereby large portions of the earth's surface most densely populated, must forever be subjected to despotic sway. Your committee, on the contrary, believe that a republican form of government possesses quite as much pliability in accomodating itself to the ever-changing condition and circumstances of mankind in his advancing civilization, as does any other form. They recognize two things as alone indispensable to republicanism, to wit; that a liberal share of intelligence, and a high moral integrity, should be largely diffused among the mass of the citizens. Wherever these two essential elements are found, republicanism can safely exist,—without them free government is only a curse.

In truth, the most careful analysis of modern civilization conclusively proves, that the more complex and varied are the pursuits of a nation, the wider and fuller must ultimately be the development given to the intellectual and moral character of its citizens.

Pennsylvania, in her widely diversified industrial pursuits, can scarcely fail to furnish motives to accomodate the taste, talent, and enterprise of every individual, whether born upon her soil or attracted hither by the fame of her wealth.

Her constitution and laws, by prohibiting the entailing of estates—securing in case of intestacy the equal distribution of assets,—and protecting even the humblest citizen in the acquisition and enjoyment of property, has provided ample barriers against the perpetuity of those accidental irregularities of wealth and social condition which ever have, and probably ever will, exist.

Whatever antagonism, real or supposable, may elsewhere be found between the kindred branches of mining, manufactures, agriculture, and commerce, between the relations of capital and labor, the employers and employed, none such can here exist. The farmer of yesterday is the manufacturer of to-day; the miner of last week the operator of next; the employed of last month the employce of this; the small dealers of last year the capatalists of this; our laws recognize no aristocracy but that of laborious, persevering industry; the strongest sinews, and the most active brains, are those that must win the prize.

Your committee cannot close this report without an earnest expression of their deep conviction, that it is the duty of the Legislature to cause the publication of the geological survey, in the most complete shape that can be given to it, for other and yet nobler reasons than the obvious ones which connect it with the industrial interests or commercial prosperity of the State. We are a singularly favored people, made by a kind Providence tenants of a fruitful soil and climate, and trustees of a treasure within the earth so rich, that our very powers of computation flag in efforts to count it over. These gifts have been bestowed on us to use for ourselves to the fullest measure of our abilities to understand and enjoy them, but likewise to transmit and to diffuse. They are a portion of the common inheritance of all mankind, and every fraternal tie that links us with our fellow-men outside our own narrow borders, every filial and grateful feeling towards the Great Parent who gave them, should prompt us to spread all the blessings they are designed to carry with them as widely around us as possible. Only by so doing, can Pennsylvania show that she appreciates and is worthy of the high career in the history of the world's progress to which she has been called; only by so doing can she show that she possesses the qualifications of a pure ambition, a liberal enlightenment, and a sense of duty to fit her to accept that exalted station which the Great Creator has assigned her amid the communities of men.